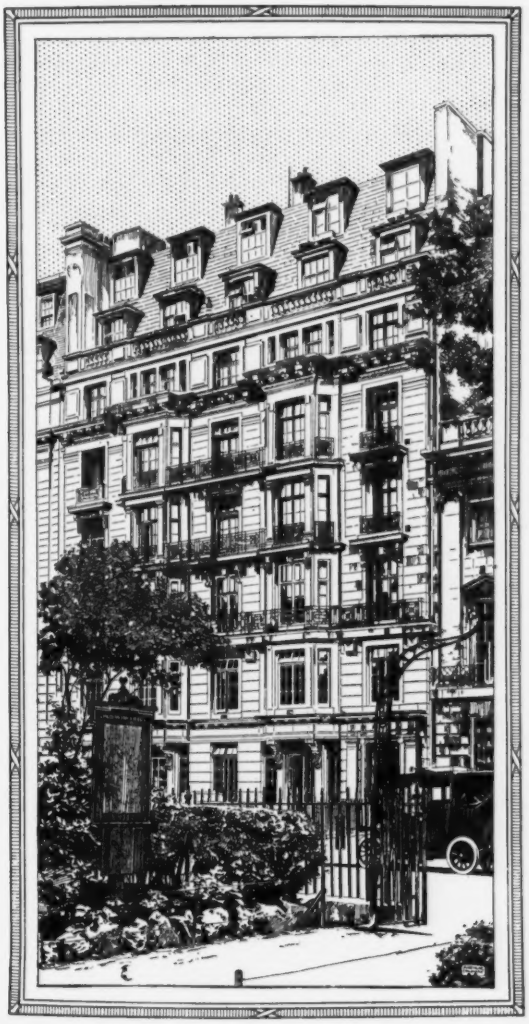
The ENGLISH ELECTRIC JOURNAL



Queen's House from Lincoln's Inn Fields.

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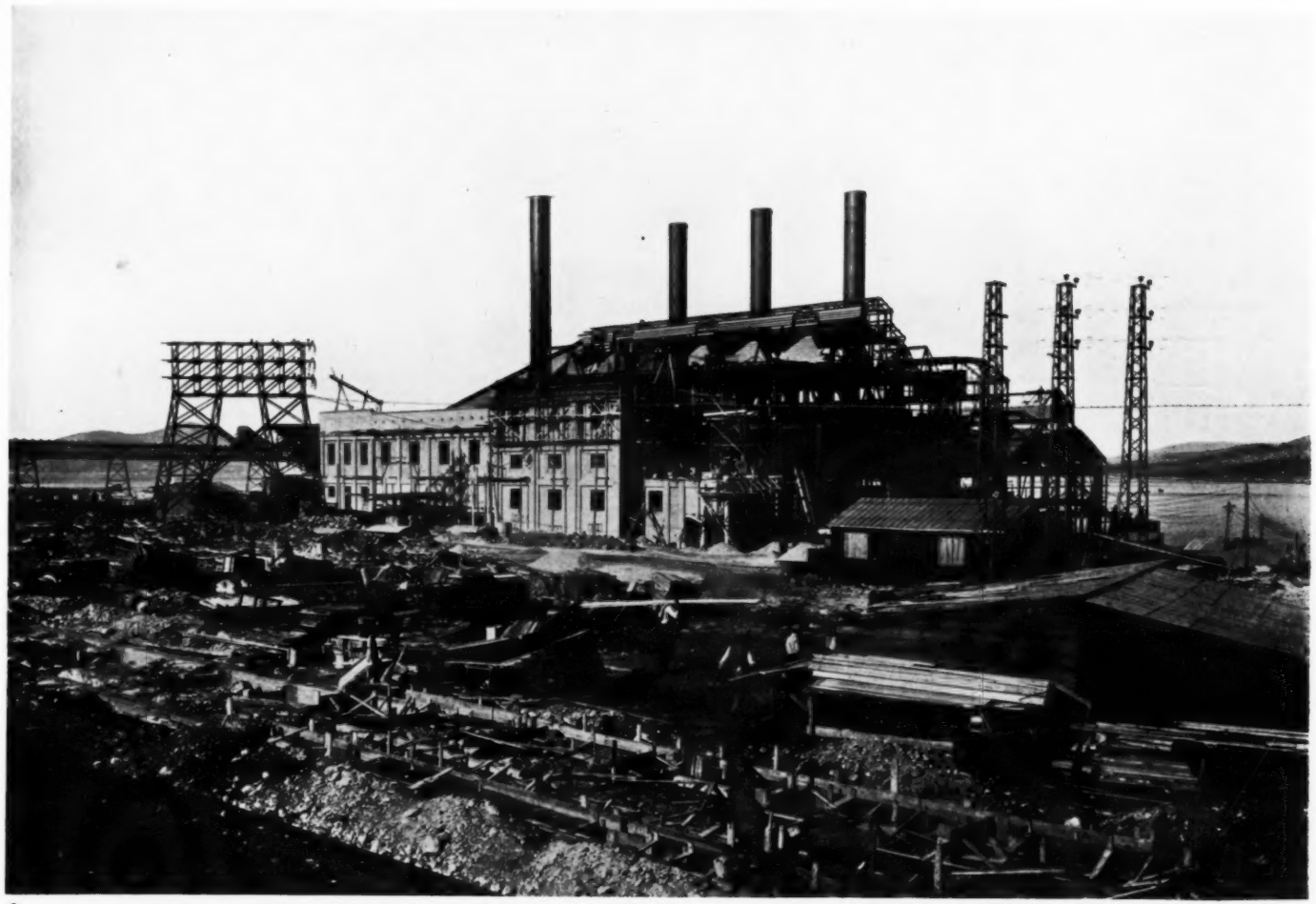

Athens.—The New St. George's Bay Power Station.

The English Electric Journal

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CONTENTS.

PAGE

SOME NEW STEAM TURBINE PLANTS - - - - - 120

EXPERIMENTAL ANALYSIS OF THE PERFORMANCE OF MULTI-CYLINDER STEAM TURBINES - 128

SOME RECENT REPEAT ORDERS - 130

TURBINES FOR SPECIAL STEAM CONDITIONS - - - - 134

TWO NATIONAL ELECTRICITY SCHEMES - - - - - 138

All Communications respecting Editorial Contents should be addressed to THE EDITOR, THE ENGLISH ELECTRIC JOURNAL, QUEEN'S HOUSE, KINGSWAY, LONDON, W.C.2.

EDITORIAL.

The manufacture of steam turbines has been one of the chief branches of the Company's work since its formation, and in previous issues of the Journal various turbine plants of special interest have been described. At the present time the Turbine Department of the Company is particularly active, and we think that it will be of interest to our readers to devote this issue to a series of illustrations of steam turbine plants that have recently been manufactured and installed.

The Rugby Works, where the turbines are made, were originally laid out for the manufacture of the Willans high-speed engine, and for several years were fully engaged on this class of work, the engines being widely adopted in this country and abroad, and being noted for the high standard of precision work employed in their manufacture. When, however, about 25 years ago, the merits of the steam turbine began to claim serious attention, the Works at once took up the new prime mover. At first it formed a side line to the engine business, but as the size of unit

rapidly increased, the steam turbines soon took first place, and " Willans " became primarily a Steam Turbine Works.

In no branch of engineering has more continuous development taken place than in steam turbine work; the size and speed of the units have been constantly increasing, steam pressures and temperatures have likewise been constantly rising, and greater economy in steam consumption has been continuously achieved. The Works have taken a leading part in all these developments, and experimental work and research have been a very important part of their activities. Their recent work in connection with higher steam pressures and multi-cylinder turbines will be well known to those of our readers who follow developments in Central Station practice, and in the following pages an account is given of some very comprehensive researches that have recently been made to analyse, as accurately as possible, the performance of each element in a multi-stage multi-cylinder machine.

The plants manufactured by the Company are installed in all parts of the world, and it will be noted that of those illustrated in this issue, many represent repeat orders, following on the successful results obtained from the original installations. The steam conditions met with in the various plants vary greatly from case to case, and examples of pass-out, back pressure, and mixed pressure installations are referred to.

The Company undertakes the complete building and equipment of Power Stations. Several contracts of this kind are referred to in the following pages, while others have been described in previous issues of the Journal. It will be realised that considerable experience is required for the successful execution of such comprehensive contracts, and the Company maintains a special staff for this class of work.

An Important Contract.—Twelve 132 kV. Outdoor Switching Stations and Control Gear have been ordered from the Company by the Central Electricity Board for erection on the primary transmission system of the S.E. England scheme, at various points in Kent, Surrey and Sussex. The stations will be equipped with oil circuit-breakers of 1½ million kV.A. rupturing capacity and isolating switches of the rotating centre-pillar type.

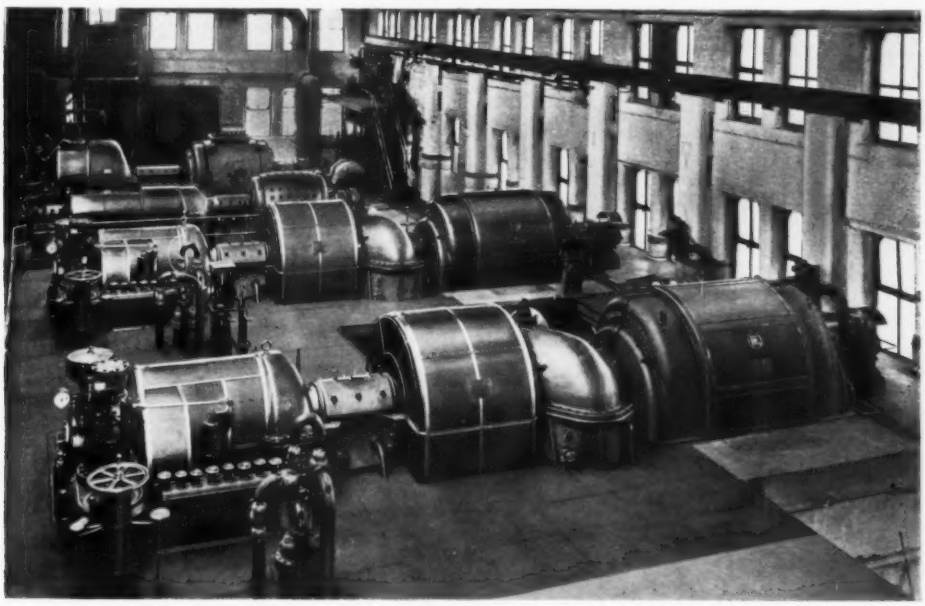
Some New Steam Turbine Plants.

Under this title have been collected a number of illustrations of steam turbo-generators installed or in course of manufacture during the past twelve or eighteen months. These are mostly of the two-cylinder type, and are all of the straight condensing type; references to special types of turbines have been reserved for a separate section of this issue.

It is considered likely to be of interest to readers if a more extended description is given

of the units which can be seen in the Huddersfield Station where two new sets seen in the foreground have recently been started up.

The illustration is one which tells quite a story to engineers who have followed the development of the Steam Turbine from its early days; the generating plant shown covers a period of just twenty years, and it would be difficult to find another instance where such a period is covered by a single photograph. Twenty years is not a long time in the history of a nation, but in the history of the steam turbine it represents a large proportion of the period which has elapsed since the first compound turbines of condensing type were put into service.



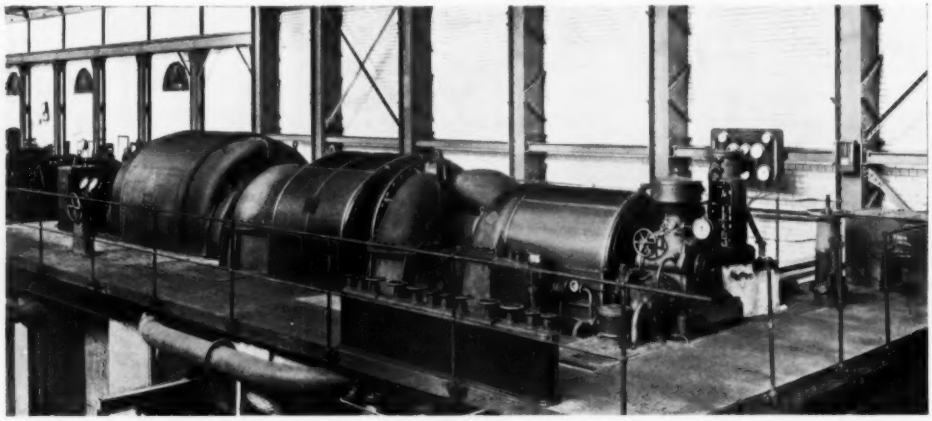
Huddersfield Corporation.—Two 6,250 kW. (M.C.R.), 3,000 R.P.M., Two-cylinder Impulse-Reaction Steam Turbines and Three-phase, 50-cycle, 6,600-volt Alternators.

All the steam turbines seen in the picture, as well as a fifth unit behind the camera, were manufactured at the Rugby Works, and the alternators at the Preston and Stafford Works of this Company. The third set from the front is a 2,000 kW., 1,500 r.p.m. reaction type turbine, coupled to a salient pole alternator. It was installed in 1908, and was one of the later of the Willans straight reaction machines. Willans was the first British company to follow Messrs. Parsons in the construction of compound steam turbines: their early turbines were all of the reaction type, but increases in temperature and pressure caused, for a time, some eclipse of the popularity of that type, since the early methods of fastening the blades left a good deal to be desired. As a result Messrs. Willans, after developing the earlier impulse reaction design of the disc-and-drum type in one cylinder, proceeded to manufacture straight impulse turbines. The fourth set seen in the illustration is an example of these machines, and was installed early in 1920; a duplicate machine installed in the Huddersfield station some three years later does not appear in the illustration. Following the highly satisfactory service given by the three older sets, two 6,250 kW., 3,000 R.P.M., two-cylinder turbo-alternator sets were ordered. These sets have "English Electric" impulse-reaction turbines,

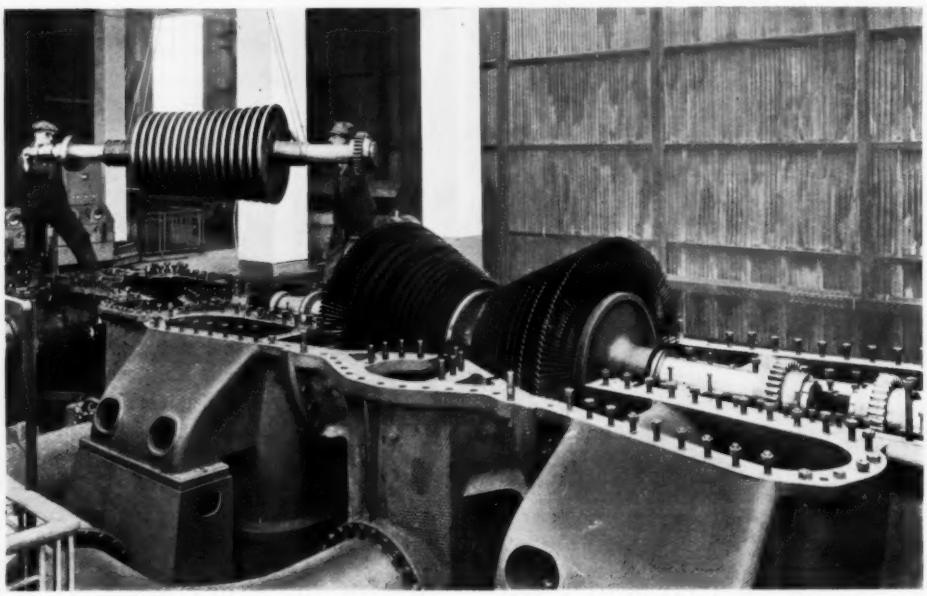
and totally-enclosed alternators provided with closed-circuit cooling systems.

They were set to work in 1927 and 1928, and being of the impulse-reaction type combine the best elements of the two earlier designs.

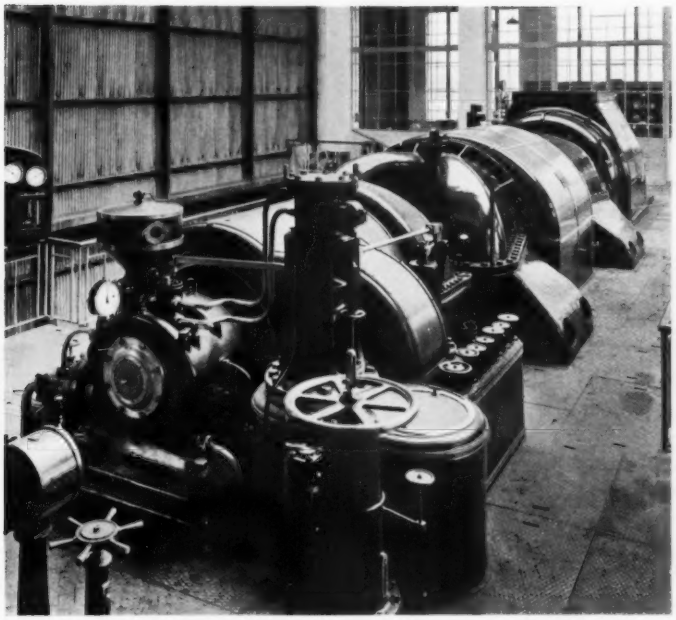
In presenting illustrations of the 12,500-kW. set installed in the new power station at Peterborough the opportunity has been taken of illustrating also the station itself, and the earlier station to which it is adjacent.



Wallasey Corporation.—12,500 kW., 3,000 R.P.M., Two-cylinder Impulse-Reaction Steam Turbine with Twin Condensers and Three-phase, 50-cycle, 6,600-volt Alternator.



Peterborough Corporation.—12,500 kW., 3,000 R.P.M., ;Two-cylinder Impulse-Reaction Steam Turbine, with Twin Condensers and Three-phase, 50-cycle, 6,600-volt Alternator. Low pressure Rotor in position; lowering High-pressure Rotor.

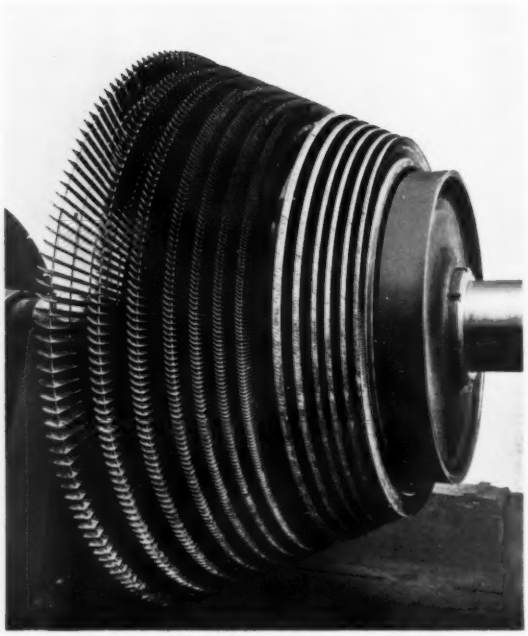


12,500 kW., 3,000 R.P.M. Turbo-Alternator Set in the New Power Station at Peterborough.

The electrical progress of Peterborough has been as striking as that of any undertaking in the country. Even in 1919 the total plant capacity was only 1,340 kW. Thereafter development was swift. The first stage was the entire reconstruction of the original station to the form shown in the left-hand view below. This comprehensive contract by the English Electric Company was completed in 1923, and there were then available 3,000 kW. of turbo-alternator plant. The new power station, which is adjacent to the old one, is from both the architectural and the engineering standpoint one of the finest in the country. The contractors for the buildings and the

Peterborough—The Old Power Station.

The New Power Station.



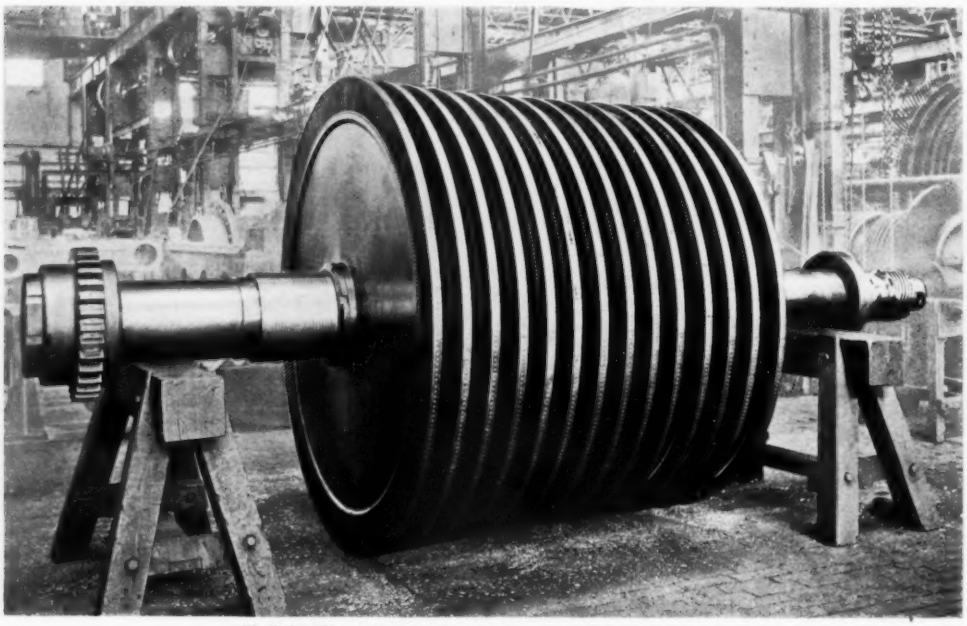
27,500 kW., 1,500 R.P.M. Turbine. L.P. Rotor.

coal and ash handling plant were the Mitchell Conveyor Company.

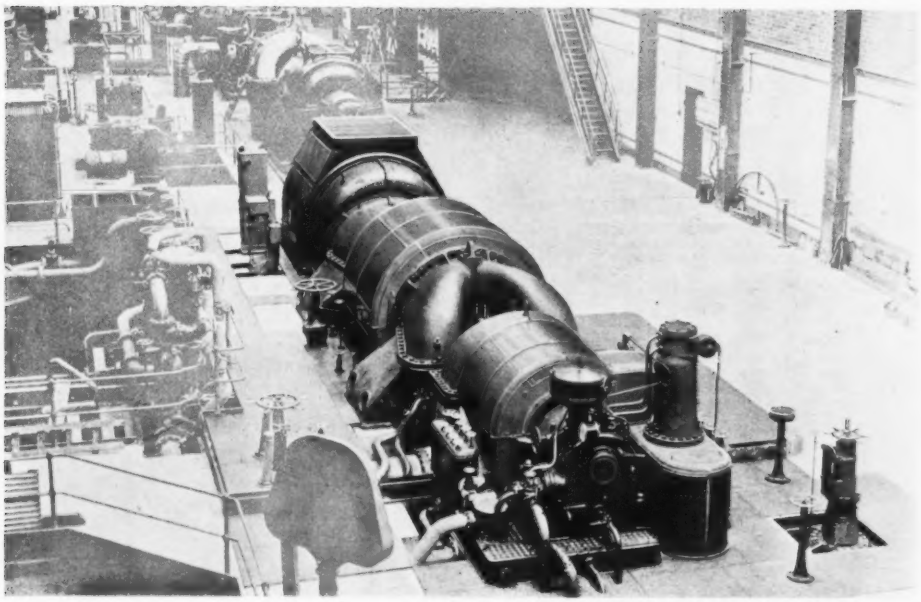
Three New Sets for Scotland.

The two illustrations on this page show the Low-pressure Rotor and the High-pressure Rotor of a recently completed two-cylinder Impulse-Reaction Turbine forming part of a 27,500 kW., 1,500 R.P.M. " English Electric " Turbo-alternator set for Glasgow Corporation. The installation of this 50-cycle set marks an important step in the unification of the supply frequency in the Central Scotland area.

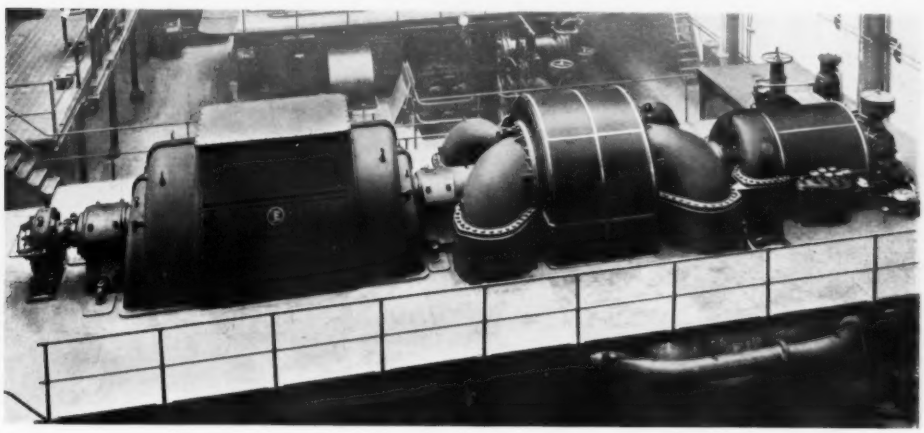
On the opposite page are views of new turbine plant in two other Scottish stations.



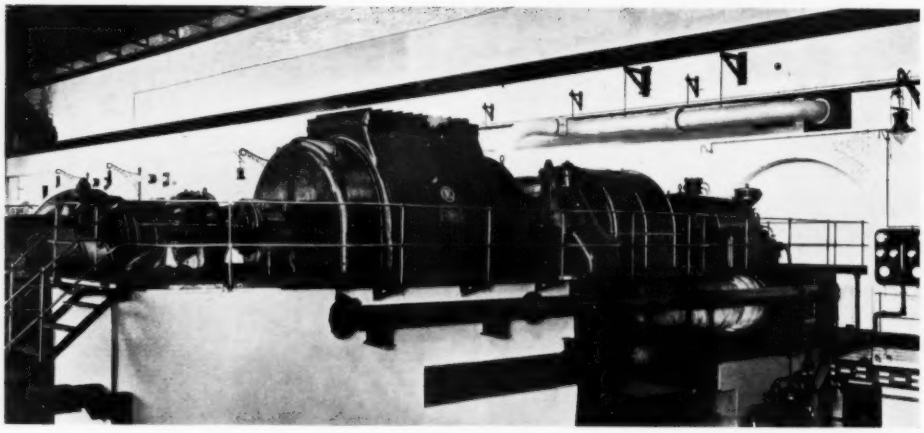
27,500 kW., 1,500 R.P.M. Turbine. H.P. Rotor.



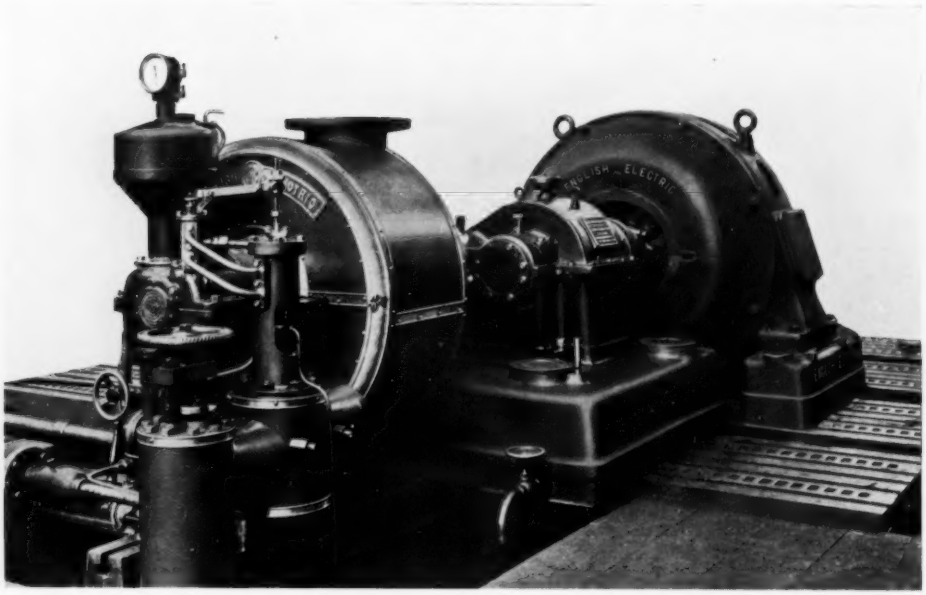
Dundee Corporation.—12,500 kW., 3,000 R.P.M. Two-cylinder Impulse-Reaction Turbo-Alternator Set and Twin Condensers. All the Generating Plant in this Station has been Manufactured by this Company or its Predecessors, who have supplied at various times two sets of 6,000 kW. at 3,000 R.P.M., two of 5,000 kW. at 1,500 R.P.M. and two of 2,000 kW. at 1,500 R.P.M.



Aberdeen Corporation.—12,500 kW., 3,000 R.P.M. Two-cylinder Impulse-Reaction Turbo-Alternator Set and Twin Condensers.

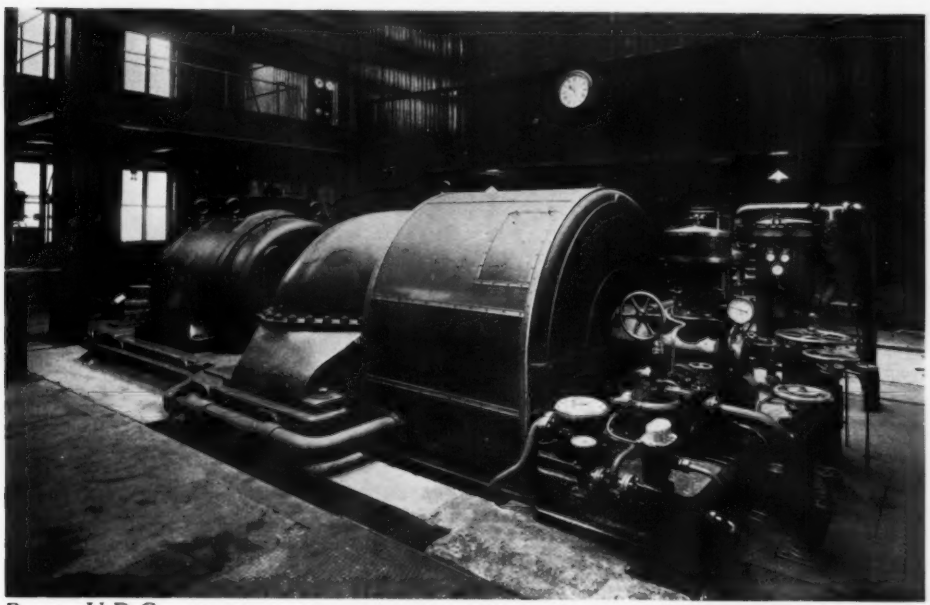


Sheffield Corporation.—One of two 12,500 kW., 3,000 R.P.M., Two-cylinder Impulse-Reaction Steam Turbines and Three-phase, 50-cycle, 11,000-volt Alternators.



Athens.—250 kW., 6,000/1,500 Geared Turbo-alternator Set for Station Service in the new St. George's Bay Power Station now being erected for the Electricity Supply of Athens by this Company and its associates. The Impulse Turbine of this set is designed to exhaust against a back pressure of 16 lbs. per square inch and the exhaust steam will be utilised in the feed water heating system. Other illustrations and references to this Power Station appear in the frontispiece and on page 138.

Messrs. Lever Brothers, Ltd.—6,250 kW., 3,000 R.P.M., Two-cylinder Impulse Reaction Steam Turbine with Condenser and Three-phase, 50-cycle, 6,600-volt Alternator. The other plant seen in this view consists of two "English Electric" units of 5,000 kW. with 3,000 R.P.M. Impulse Turbines.



Barnes U.D.C.—3,750 kW., 3,000 R.P.M. Impulse Turbine with Condenser and Three-phase, 50-cycle, 6,600-volt Alternator. Other "English Electric" plant supplied to this Undertaking includes two 1,500 kW., 3,000 R.P.M. sets.

Experimental Analysis of the Performance of Multi-cylinder Steam Turbines.

During the last four years the English Electric Company have developed a complete range of two-cylinder 3,000 r.p.m. machines, these being all of the Impulse-Reaction type.

This type was adopted after lengthy experiments with turbines both of the reaction and impulse types, and the principal considerations which led to its adoption may be stated briefly as follows :—

With the high steam pressures and steam temperatures used to-day it is desirable to use a separate turbine for expanding the steam down to moderate pressure and temperature. The impulse turbine stands out as the best type for this purpose. The design of impulse high-pressure turbine constructed by this Company is a short and compact machine, well suited for use with steam of high pressure and temperature, in which there are no fine clearances, no end-tightening adjustments with varying load, and no balancing dummies.

Maximum efficiency and the highest standard of reliability are secured by the use of diaphragm nozzles built up from solid steel blocks and the adoption of a solid rotor construction with very low stresses and surface speeds.

The reaction principle, owing to its higher inherent efficiency, its simplicity, and for other reasons, is the best for the low-pressure turbine. As in the high-pressure unit, a solid rotor is used running below the first critical speed. By employing a symmetrical double exhaust in the larger sizes, no balancing dummies are required, and the steam exit losses and blade stresses are kept low without complicated exhaust passages or fine axial clearances.

The development of a line of machines ranging from 6,000 kW. up to 30,000 kW. has involved a very large amount of experimental work, and the collection from many sources of a mass of data which has been applied in the elaboration of the designs. In particular it was found desirable to analyse with great accuracy the performance of each element of these multi-stage multi-cylinder machines. Without such an analysis it is impossible to get the highest efficiency in each stage of such a turbine, and without a proper balance between the different portions it would be impossible to attain the efficiencies which are being realised to-day.

A number of turbines have, therefore, been dealt with experimentally on the following lines. In some cases the low-pressure turbine has been disconnected from the high-pressure turbine and has been run as a separate unit, while in other cases independent tests have been made on the high-pressure turbine. As an example of the work that has been done in this way refer-

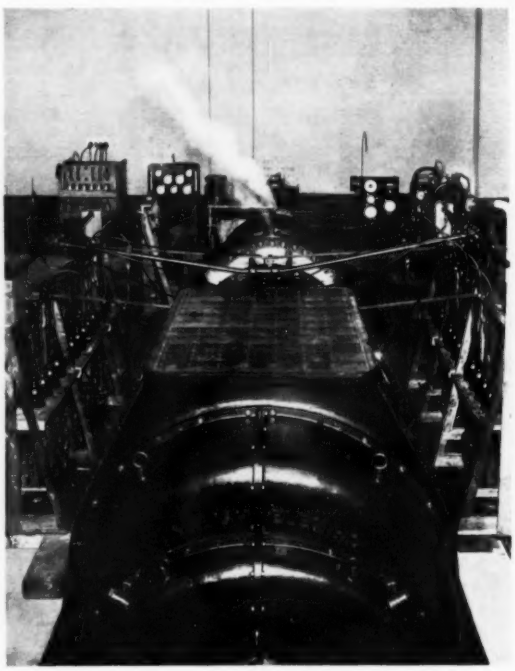


FIG. 1. 16,000 kW. TWO-CYLINDER TURBO-ALTERNATOR AND TEST APPARATUS.

ence may be made to Figs. 1 and 2 showing a 16,000-kW., 2-cylinder turbine installed in a Power Station, and fitted up for the tests. The apparatus shewn has enabled the performance of both the high-pressure and the low-pressure turbines to be investigated with the greatest accuracy. It must be realised that owing to the velocities of the steam passing through a modern turbine it is a matter of great difficulty to measure accurately small differences of pressure; the mere fitting of a pressure gauge at each stage of a reaction turbine is likely to give very misleading results, and, therefore, the Engineers of this Company adopted very special methods in making these measurements. The apparatus has been used on every type of steam turbine; pure impulse turbines up to sizes of 15,000 kW. have been fully investigated and a reaction machine of a similar size has also been tried out. Fig. 2 shows a number of flow-meters coupled through water bottles to the different stages of a two-cylinder impulse-reaction turbine; the flow-meters provide an accurate way of measuring the small differences of pressure across the various stages of a low-pressure reaction turbine, and the results have been analysed and brought into everyday use.

The same apparatus was used in another power station to get information on the effect of superheat as applied to the L.P. turbine. A low-pressure double-flow reaction turbine was disconnected from its high-pressure turbine and supplied with steam through a reducing valve with a de-superheater attached. In order to run the low-pressure turbine independently a number of somewhat difficult problems had to be solved, since under these conditions the low-pressure turbine was necessarily disconnected from all its usual governing mechanism. Arrangements had, therefore, to be made to provide for regulating its speed, and also to prevent any danger of over-speeding. Special gear was designed and interconnected not only with the main stop valve of the turbine, but also with the switchboard, so

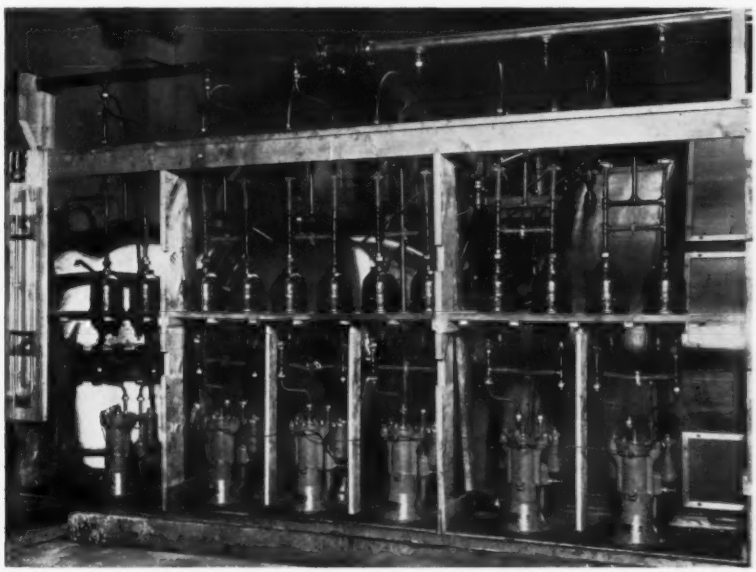


FIG. 2. ARRANGEMENT OF FLOW-METERS CONNECTED TO THE SEVERAL STAGES OF A TWO-CYLINDER IMPULSE-REACTION TURBINE.

that in any emergency the steam would be shut off and the machine would be disconnected at once from the station busbars. With steam supplied through a reducing valve and with the de-superheater in use, it was possible to vary within wide limits the temperature of the steam supplied to the low-pressure turbine. A very large number of tests were made with this apparatus at various loads and with steam at various temperatures and degrees of wetness. This information is of two-fold value, firstly, as enabling designers to deal with the serious problems involved by wetness at the low-pressure end of a steam turbine, and, secondly, because it has supplied a mass of information regarding the behaviour of steam at various temperatures in a low-pressure turbine. This information is of the greatest importance at the present time when so much consideration is being given to the effect of re-heating the steam between the high-pressure and low-pressure cylinders of a multi-cylinder turbine.

Some Recent Repeat Orders.

In referring to a number of orders received recently for generating units to be installed in stations where " English Electric " steam turbo-alternator sets of the same, or very similar, type and size have been installed only a year or so before, it is of some interest to append the particulars of the new plant to illustrations of its predecessors, giving in each case brief chronological and technical references.

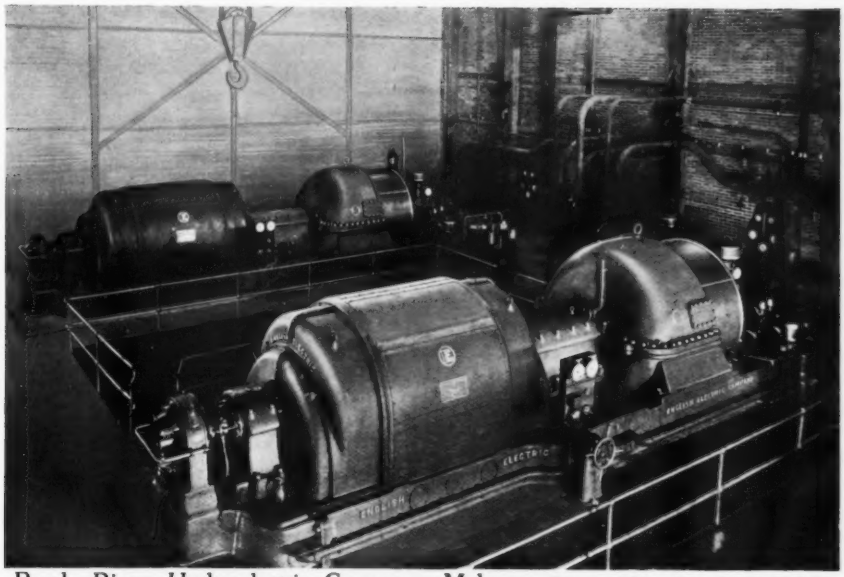
This Company took an active part in the building and equipment of many of the new power stations erected in the early post-war years, and after a relatively short period it is now supplying for many of these stations new units, the average output of which is steadily increasing so that whereas units of 10,000 kilowatts were quite usual five years ago, sets of 25,000 to 40,000 kilowatts are now being built for many undertakings.

Much interesting information might be given concerning the development of any of the undertakings represented by the illustrations, but space permits only a few notes on two of them.

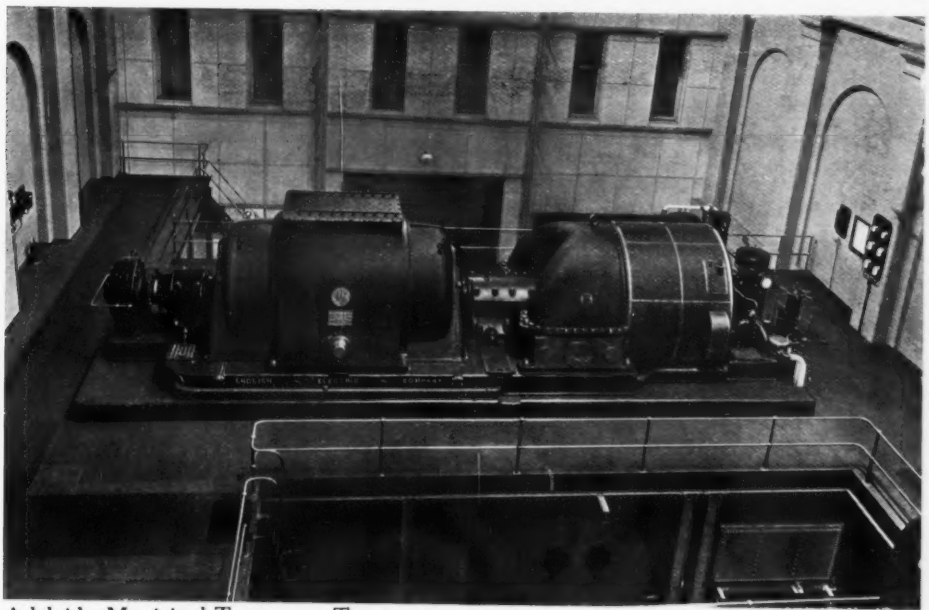
The steam station of the Perak River Hydro-Electric Company at Malim Nawar has been put down for the dual purpose of enabling the Company to give a supply while the extensive works of the water-power station at Chenderoh are being completed, and of supplementing the output from the hydro-electric station at times of low water. The two sets shown were ordered in the spring of last year, but the applications for power came in so rapidly that a third set was ordered a few months ago. In addition to these steam sets The English Electric Company have participated in this enterprise to the extent of of supplying three water-turbine alternators, each of 12,350 kVA., at a speed of 93.75 r.p.m. These machines, which are under construction at Stafford Works, will be of very large dimensions and considerable technical interest.

The Bradford undertaking has become noted for the progressive policy pursued, under the inspiration of Mr. T. Roles, the Chief Engineer, in the application of the most modern ideas in power station technique. The 20,000-kW., two-cylinder impulse-reaction turbine put down in 1925 was at the time of its installation, the largest turbine so far built to run at 3,000 r.p.m., and the first of its particular type. At a later date keen interest was taken by all power station engineers in the adoption by the Committee of plans for the installation of an extra-high pressure turbo-alternator unit to operate with steam at a pressure of 1,000-lbs. per square inch, and to exhaust into the existing steam range of the station ; an illustration of the steam turbine rotor of this set appears on page 137.

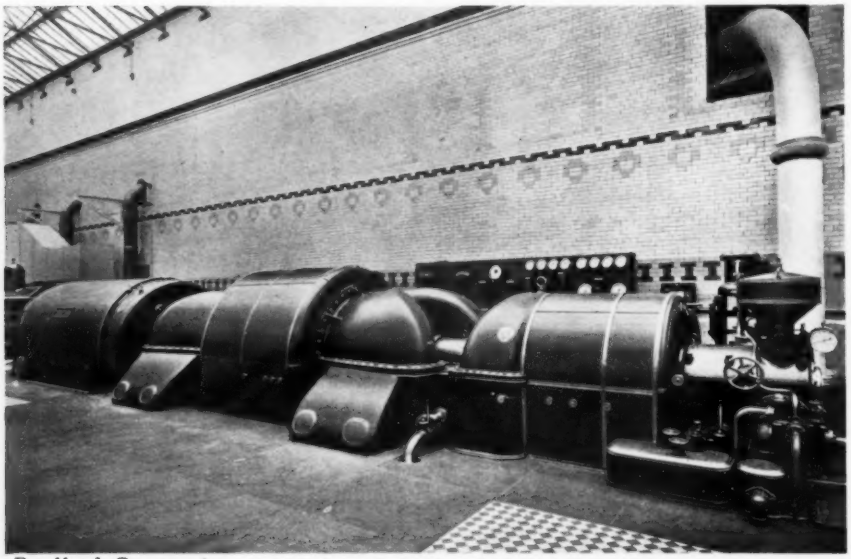
The capacity of the Valley Road Station is also to be increased by the addition of a 30,000 kW. set, and the " English Electric " turbine of that output will represent the latest design of multi-cylinder 3,000 r.p.m. machine. There are now under construction at Rugby Works two turbines of this size, the second being for the 30,000 kW. turbo-alternator set ordered earlier in the year by the West Ham Corporation.



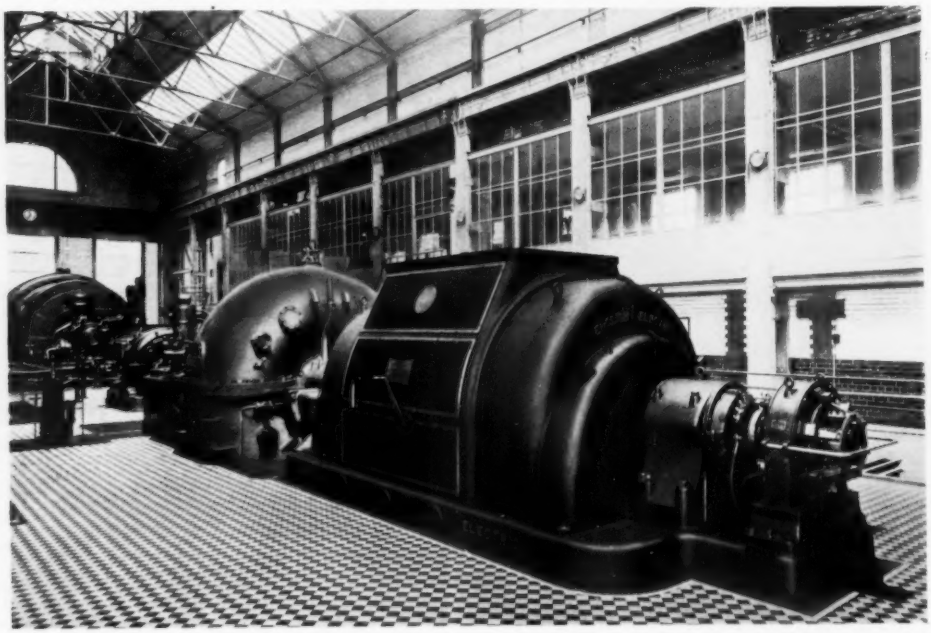
Perak River Hydro-electric Company, Malaya.—Two 6,000 kW., 3,000 R.P.M. Turbo-Alternator Sets and Condensing Plants have just been erected at the Malim Nawar auxiliary station. A third set of the same size is now in hand. Reference is made to this plant on the previous page.



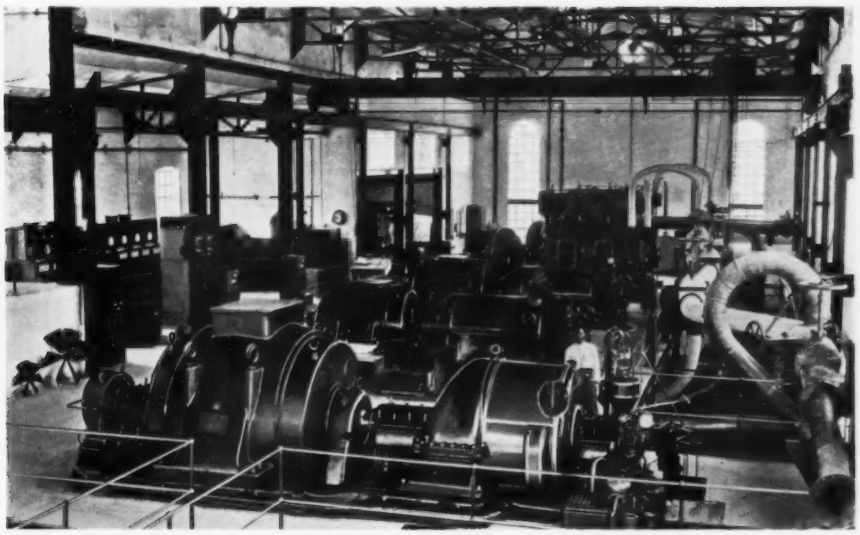
Adelaide Municipal Tramways Trust.—Another Set similar to the one illustrated has recently been put in hand for this customer. The plant shown was installed in 1925 and consists of a 10,000 kW., 1,500 R.P.M. Steam Turbine and 11,000 volt, 25-cycle Alternator, complete with Surface Condenser.



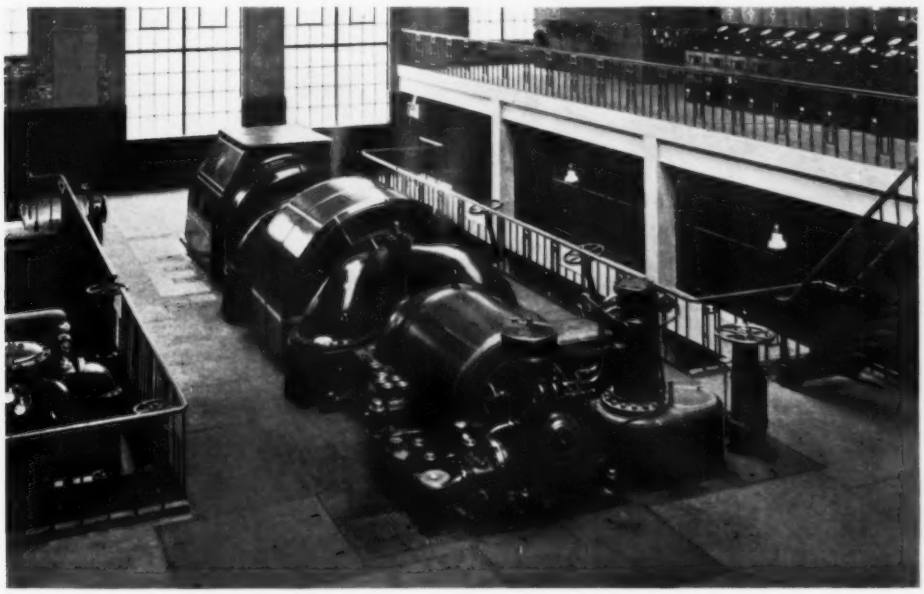
Bradford Corporation.—A 30,000 KW., 3,000 R.P.M. MULTI-CYLINDER STEAM TURBINE AND CONDENSING PLANT HAVE BEEN PUT IN HAND FOR THIS STATION. THIS WILL BE SIMILAR IN SIZE AND DESIGN TO A SET UNDER CONSTRUCTION FOR WEST HAM. THE 20,000 KW. TURBINE ILLUSTRATED WAS SET TO WORK IN 1925, AND WAS THE FORERUNNER OF SOME 700,000 H.P. OF TWO-CYLINDER TURBINES WHICH HAVE BEEN ORDERED FROM THIS COMPANY.



Leicester Corporation.—THE NEW ORDER IS FOR A 25,000 KW., 3,000 R.P.M. STEAM TURBO-ALTERNATOR SET COMPLETE WITH CONDENSING PLANT. THE CENTRAL GENERATING STATION ILLUSTRATED ABOVE WAS ERECTED IN 1922 BY THIS COMPANY AND EQUIPPED WITH THE 12,500 KW., 1,500 R.P.M. SET SEEN IN THE BACKGROUND; IN 1926 THE 12,500 KW., 3,000 R.P.M. SET WAS ADDED.



Anglo-Persian Oil Company.—For their power station at Tembi, Persia, a second 3,000 kW., 3,000 R.P.M., Turbo-Alternator set has just been ordered. The set seen in the foreground was set to work last year and formed part of a comprehensive contract for extensions to the station.



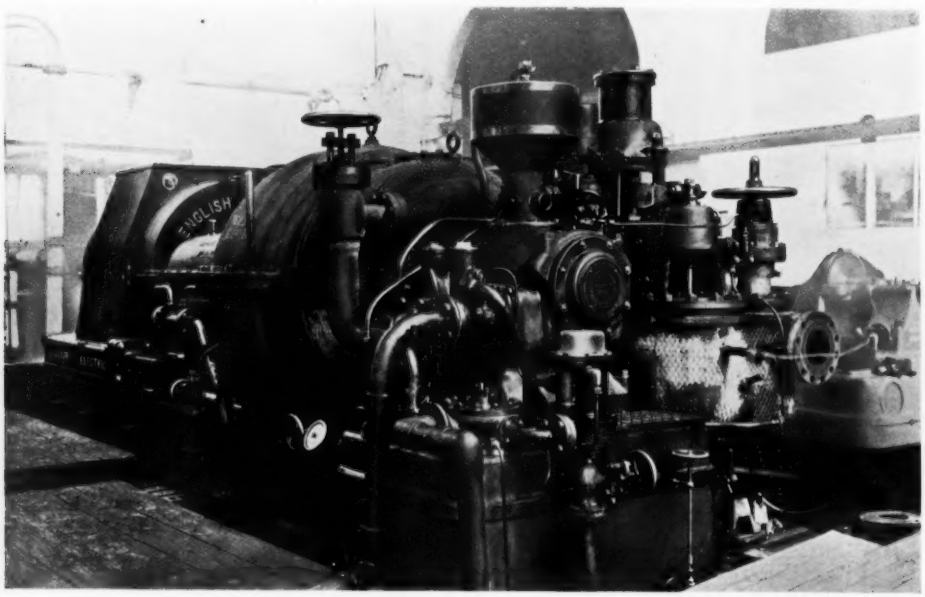
Messrs. Edward Lloyd, Ltd.—The last issue of this journal contained a full description of the comprehensive contract for the power station illustrated above. An order has now been received for a duplicate two-cylinder Turbo-Alternator set and condenser of 12,500 kW., at 3,000 R.P.M.

Turbines for Special Steam Conditions.

Although mechanical power in some form or other is a necessity of practically every industry and the transmission of power for use in that form is the basis of present electricity supply development, yet linked with the demand for mechanical power on the one side, and with the supply of electrical energy on the other, are almost innumerable purposes for which energy is required in the form of heat at relatively low temperatures. The cheapest and most convenient method of applying heat of this kind required in industrial processes is by means of steam at low pressures, but it is well-known to heat engineers that the use of steam direct from boilers for this purpose alone, is extremely uneconomical if there is any outlet for the mechanical power which can be produced from the same steam with the use of a very small additional amount of fuel.

The importance of this was shown in an article by Mr. A. H. Law, General Manager of the Rugby Works, in an article contributed to the "Times Trade & Engineering Supplement." In the following table he illustrates how a large amount of power can in this way be generated at a very low cost. It is assumed that in each case there is a constant demand for process work of

—	Case 1. Boilers Generating at 30 lb. per sq. in No superheat.	Case 2. Boilers Generating at 150 lb. per sq. in. 500° F. temp	Case 3. Boilers Generating at 500 lb. per sq. in. 750° F. temp.
Process steam (lb. per hour at 30 lb. gauge)	184,000	184,000	184,000
Electrical units generated per hour	0	4,200	9,850
Coal burnt (lb. per hour)	22,700	24,000	25,500



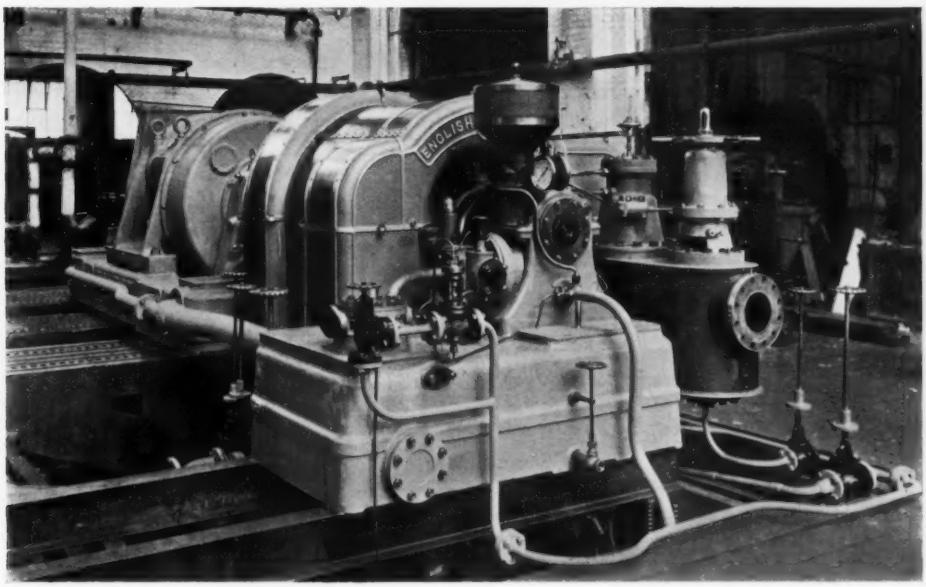
Pass-out Turbo-alternator Set for an Indian Textile Mill.—This is a 1,100 kW., 6,000/1,500 R.P.M. Set to which steam is supplied at 200 lbs. per square inch, 650° F. total temperature. 10,000 lbs. of steam per hour can be extracted at 30 lbs. per square inch pressure. The Turbine exhausts into an "English Electric" Surface Condenser.

184,000 lb. of steam per hour at a pressure of 30 lb. gauge.

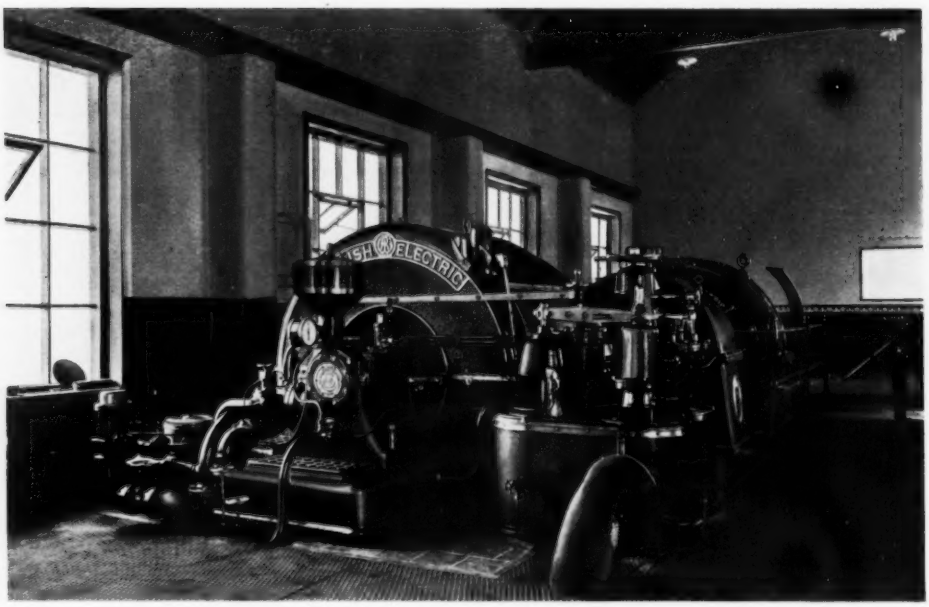
Comparing Cases 1 and 3 it will be seen that for an additional expenditure of 2,800 lb. of coal per hour nearly 10,000 units of electricity can be generated. This power is practically a by-product of the process steam and taking the price of coal at 20s. per ton the coal cost of these units works out at only 0.03d. per unit, a figure with which no other method of generating electricity from fuel can possibly compete. These figures may be taken *pro rata* for larger outputs. For smaller outputs the saving will still be very great even down to steam quantities and powers as little as one-twentieth of those given in the table; but for such outputs some lower pressure than 500 lb. per sq. in. would generally be recommended.

General View of the Yallourn Briquetting Plant.

This Company has had the good fortune to be brought in touch with many industries where a study of the combined mechanical power and heat requirements has enabled them to provide



Back-Pressure Turbo-Alternator set for an Indian Chemical Works.—This Set has a normal output of 900 kW.; it operates with steam at 200 lbs. per sq. inch, and exhausts against a back pressure of 30 lbs. per sq. inch, the exhaust steam being used for the Chemical Processes.



Mixed Pressure Turbo-generator Set at Griff Colliery, Nuneaton.—THIS 1,390 kW., 3,000 R.P.M. TURBINE IS COUPLED THROUGH GEARING TO A 750 R.P.M., 1,250 kW., D.C. GENERATOR AND A 149 kW. BOOSTER. LIVE STEAM IS SUPPLIED AT 85 LBS. PER SQUARE INCH, AND EXHAUST STEAM AT 16 LBS. PER SQUARE INCH FROM RECIPROCATING ENGINES.

plant for supplying those requirements in a highly economical manner by the provision of pass-out or back-pressure steam turbines, and the illustrations in this section draw attention to some examples of such installations.

In that they are directed especially to the more economical use of fuel, some reference is also made to power station turbines for use on extra-high-steam pressures, and to turbines of the mixed-pressure type for utilising exhaust steam already available in industrial steam plants.

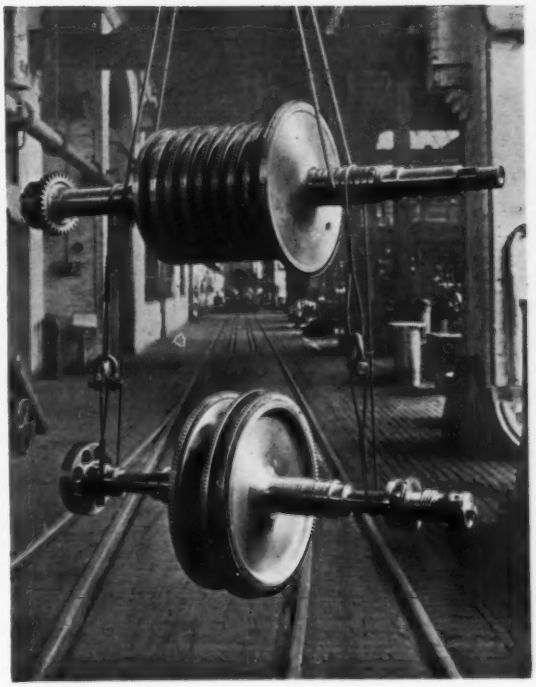
Where steam for process purposes is to be taken from a steam turbo-generator set, the decision as to whether the low-pressure steam shall be taken from some intermediate stage of the turbine or from the exhaust, i.e. whether an extraction or a back-pressure turbine is to be adopted depends upon the balance that can be struck between the electrical energy or mechanical power taken from the turbine and the quantity of steam required for the processes. When the whole of the steam corresponding to the electrical requirements of the factory can be utilised for heating, or, on the other hand, when use can be found for all the electrical energy corresponding to the steam requirements, then a back-pressure turbine can be installed and greater economy realised than if a pass-out turbine were adopted.

One of the largest back-pressure plants so far contemplated is that for which this Company has received an order from the State Electricity Commission of Victoria for installation in the Yallourn Briquetting Factory. The vast deposits of brown coal in Victoria have been developed on national lines, and the principal deposit in the Latrobe Valley, about 100 miles from Melbourne, is the site of a great national power station and a briquetting works from which fuel is supplied for general sale in Melbourne and the surrounding districts. It is of interest to mention that the deposit in question covers an area of

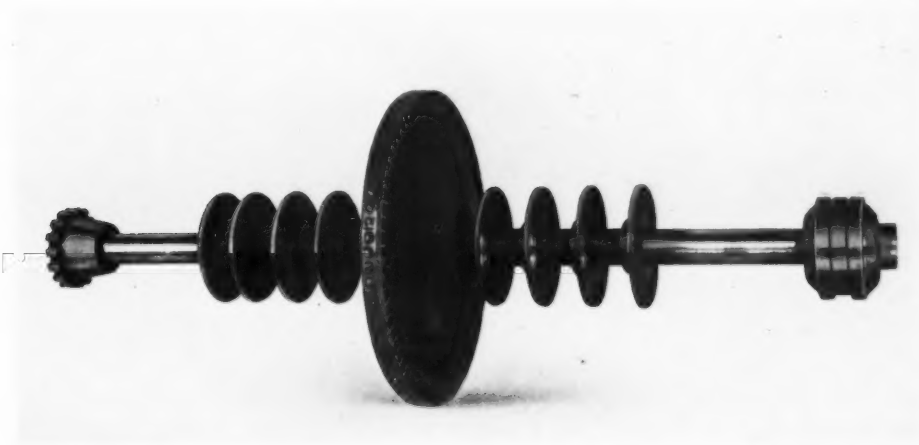
about 800 square miles, and it is estimated that at least 20,000 million tons of brown coal can be won by surface workings.

As is well-known the great disadvantage of this class of fuel is the excessive moisture content. The raw coal of the Latrobe Valley fields has an average moisture content of 60 per cent., and calorific value of about 4,000 B.Th.U., but when briquetted the product has only 14 per cent. moisture, while the calorific value is about 9,000 B.Th.U. The practicability of drying and pressing the coal into briquettes on a commercial scale rests upon the use of a highly economical method of drying and it is not surprising to find that the factory which has been in operation since 1925 is equipped with back-pressure turbo-alternator plant from which is drawn the steam required for drying and pressing, while the electrical power that is surplus to the requirements of the factory is transmitted to the main power station which is only a few miles distant.

The first extension of the original factory is now being undertaken and the new power plant that has been put in hand consists of two 10,000 kW. "English Electric" back-pressure turbo-alternator sets. These will be of the Impulse type running at 3,000



Bradford Corporation.—THE UPPER ROTOR IS FOR A 2,500 kW., 6,000/1,000 R.P.M. TURBO-ALTERNATOR SET TO OPERATE WITH STEAM AT 1,000 LBS. PER SQ. INCH, 775°F.



ROTOR OF EXPERIMENTAL TURBINE DESIGNED TO OPERATE WITH STEAM AT 1,422 LBS. PER SQ. INCH.

r.p.m., and will be designed to take steam at 565 lbs. per square inch, 725 deg. F. total temperature and exhaust at 55 lbs. per square inch.

Extra-high Pressure Steam Turbines.

This Company has been associated with much of the pioneer work on the use of very high steam pressures for central station turbines.

It will be remembered that Mr. T. Roles, the Chief Engineer of the Bradford Electricity Department decided to adopt a novel combination of plant with a view to increasing the capacity and economy of the Valley-road Station to the highest extent possible within the available space. The plant when completed will consist of an 1,100 lbs. per square inch boiler, a 2,500 kW. back-pressure turbo-alternator and a 30,000 kW., 3,000 r.p.m. multi-cylinder turbo-alternator. The back-pressure turbine, the rotor of which is illustrated, will take steam at full pressure from the boiler and will exhaust into the normal-pressure steam mains of the station.

The lower rotor in the picture is that of the 250 kW. turbine shown in the lower illustration on page 126.

The illustration at the foot of page 137 shows the rotor of an experimental turbine constructed to work with steam generated in a Benson Boiler at the critical point corresponding to a pressure of 3,200 lbs. per square inch and 706 deg. F. total temperature. The normal running speed was 25,000 r.p.m., and the output 360 kW., when steam was supplied at 1,422 lbs. per square inch, 842 deg. F.; it exhausted at a pressure of 213 lbs. per square inch. The diameter of the single wheel is 9.65 inches.

Two National Electricity Schemes.

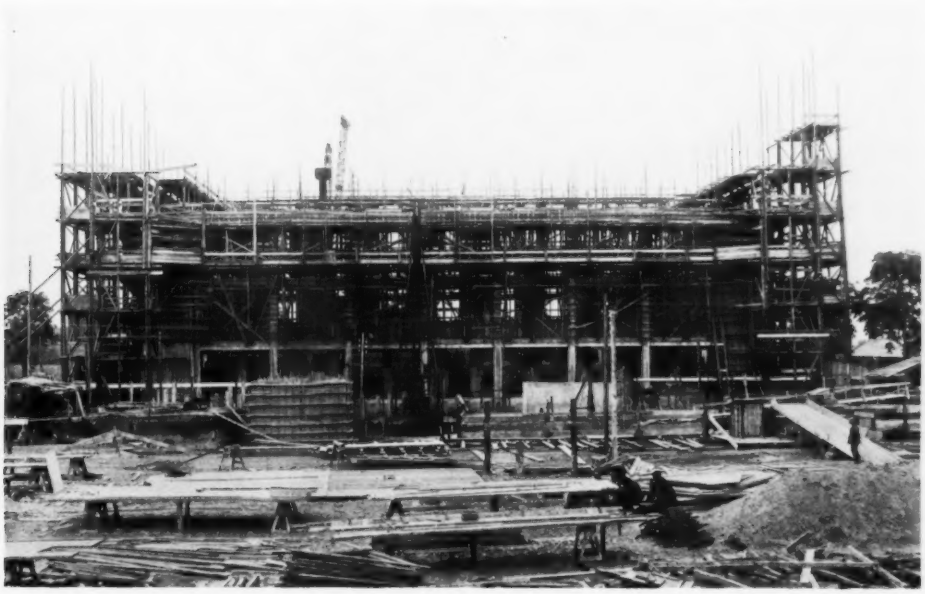
It is hardly necessary to remind readers that an important branch of this Company's activities has always been the undertaking of comprehensive contracts, either for electricity supply on any

St. George's Bay Power Station, Greece.—Erection of the 15,000 kW. Turbo-Alternator sets is proceeding concurrently with the power house building. The L.P. Cylinders of two of the three sets are seen, and in one the L.P. and H.P. Rotors are also in position.

scale or for complete schemes of electrification of any description, whether of industrial works, of railways, of road transport or of other public services. It would not be possible to find better examples of this phase of its work than the two national schemes concerning which it is now possible to give some brief particulars and illustrations.

In October, 1925, a concession for the complete rehabilitation and operation of the electricity supply and transport services of Athens, the Piraeus and their environs was granted to the Power & Traction Finance Company and its Associates in Greece. In the period that has elapsed, a vast amount of work has been done, much of which has been directed to the immediate alleviation of the unsatisfactory condition of the existing services. But, as may be judged from the illustration which forms the frontispiece of this issue, no inconsiderable progress has been made with the major works, amongst which the most important is the new Power Station at St. George's Bay, about two miles north-west of the Piraeus. This has been built on solid rock foundations close to the sea, and is being equipped in the first instance with three 15,000-kW. 3,000 r.p.m., two-cylinder, turbo-alternator sets, two of which can be seen in course of erection in the illustration opposite. Very complete arrangements have been made for the unloading of coal directly from sea-going vessels, and these have been utilised for the materials and plant for the station. Power will be transmitted at 22,000 volts to distributing centres, and thence to substations serving the general power and lighting network and the Athens-Piraeus and Athens-Kephissia Railways. The whole of the plant, switchgear and rolling stock is being supplied by this Company.

The Power & Traction Finance Company, in association with Messrs. Ganz of Budapest, completed in the Spring of this year, negotiations with the Hungarian Government for the carrying out of a scheme of electricity supply for Budapest and the surrounding district, and the electrification of the main line railway from Budapest



Hungarian State Power Station, Banhida.—THE CONTRACT FOR THIS STATION AND OTHER EXTENSIVE WORKS IS BEING EXECUTED IN CONJUNCTION WITH MESSRS. GANZ.

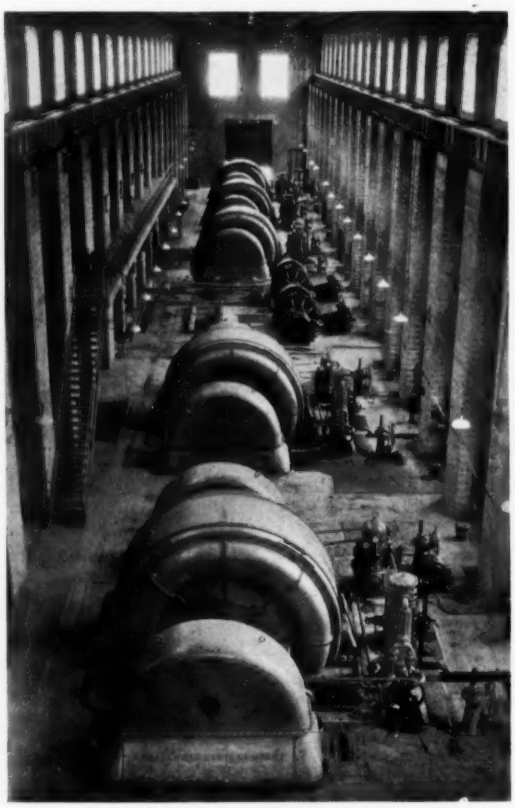
to the Austrian frontier. The English Electric Company will supply the main turbines, condensing plant and other auxiliaries, the 110 kV. power house switchgear and transmission lines, and the complete equipment of the substations.

The new Power House, which is being erected by Messrs. Ganz on the shore of a small lake near the village of Banhida, about 37 miles west of Budapest, will utilise coal from a mine some $3\frac{3}{4}$ miles distant. The initial equipment of the station will consist of three 23,000 kW., 3,000 r.p.m., two-cylinder turbo-alternator sets, and a 2,100 kW. house service and line-charging set. For stepping-up the output for transmission there will be installed four three-phase, forced oil-cooled transformers, each of 25,900 kVA. In addition to the transmission line eastward to Budapest, a distance of 37 miles, another line, 63 miles long, will run westward to Moson.

A 150,000 H.P. POWER STATION.

This illustration will remind readers that "English Electric" Power Station Plant is not restricted to Steam Turbine driven sets. It is reproduced from a photograph just received from India and shows the completed erection in the Bhira Station of the Tata Power Company, of Five 30,000 H.P. Twin Impulse Water Turbines manufactured at Rugby, with alternators manufactured at Preston.

Space is not available to show an example of the third type of Prime Mover produced at the Company's Rugby Works. This is the Fullagar Opposed-piston Oil Engine which has established for itself a definite field in power station practice throughout the world.



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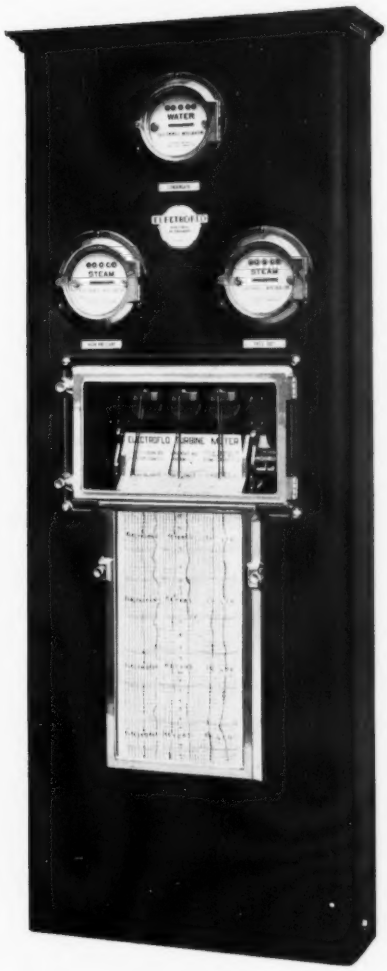

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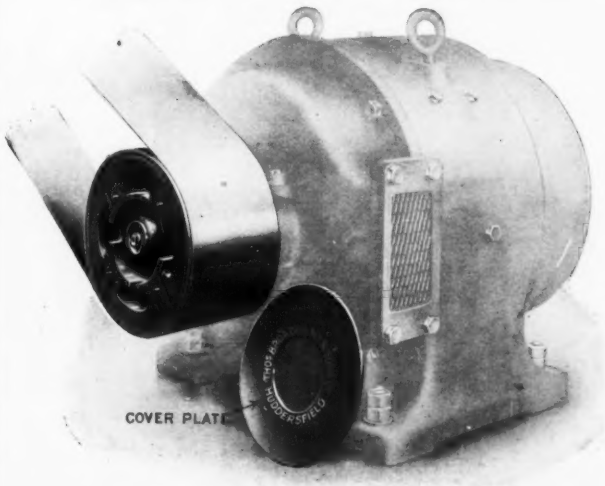

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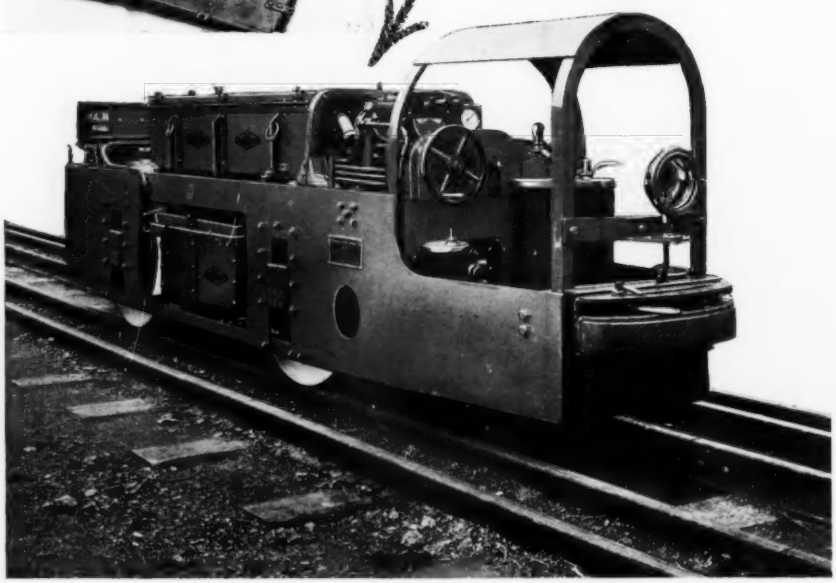

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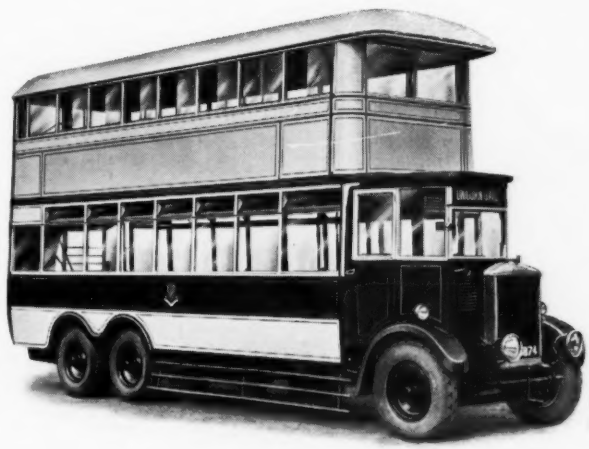

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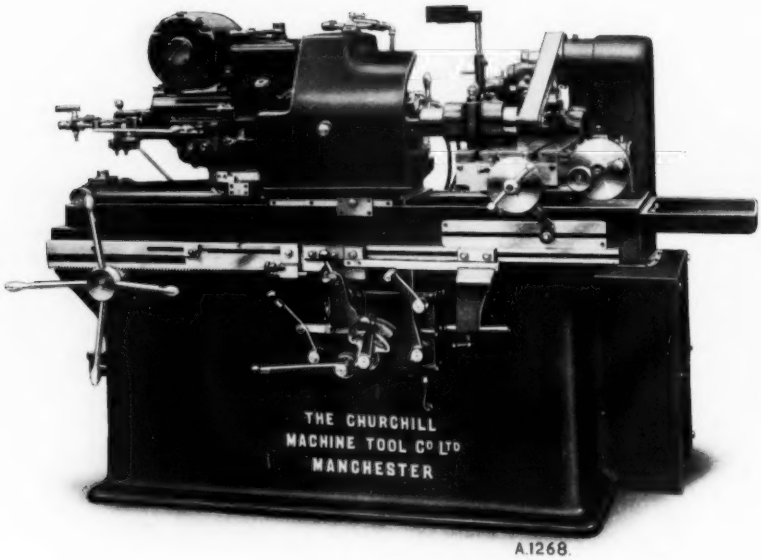

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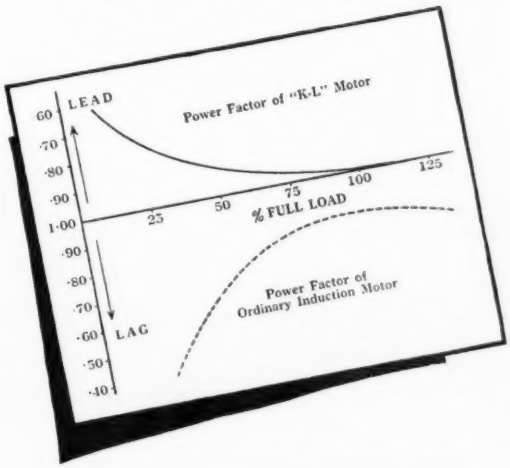

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INDEX TO ADVERTISERS

Alfa-Laval Co., Ltd. V
Associated British Machine Tool Makers, Ltd. XVIII
Attwater & Sons XIII
Broadbent, Thos. & Sons, Ltd. XIII
Craske, Alfred, Ltd.... XVII
Davy Brothers Ltd. IX
D. P. Battery Co., Ltd. XVI
Electroflo Meters Co., Ltd..... XI
English Electric Company, Limited VIII, XII, XVII, XIX
Equipment & Engineering Co. Ltd. XIV
Green, E. & Son, Ltd. V
Heenan & Froude Ltd. VI
London Electric Wire Co. & Smiths Ltd. VI
Marelli & Co., Ltd. XV
Mason, E. N., & Sons, Ltd..... VII
Mitchell Conveyor Co. Ltd. III
Renold, Hans, Ltd. II
St. George's Engineers Ltd. IV
Siemens Brothers & Co. Ltd. X
Straker Brothers, Ltd. XX
Strathclyde Paint Co., Ltd. IX
Taylor, Tunnicliff & Co., Ltd. II
Whitehead Letter File Co. XIV
Yorkshire Copper Works, Ltd. I

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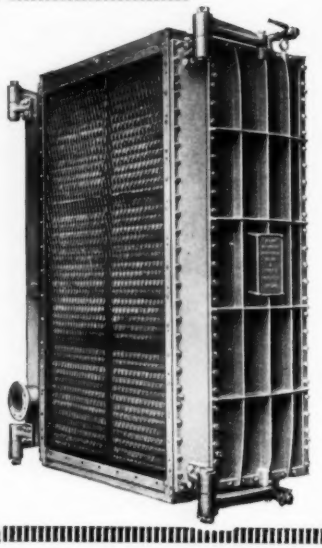

A plentiful and continuous supply of cool, clean, dry air is assured by means of this system of ventilation. All dirt and free moisture are excluded and risk of fire reduced to a minimum. Moreover, these Coolers are simple to operate, reliable in action, inexpensive and suitable for working in conjunction with any make of alternator on the market.

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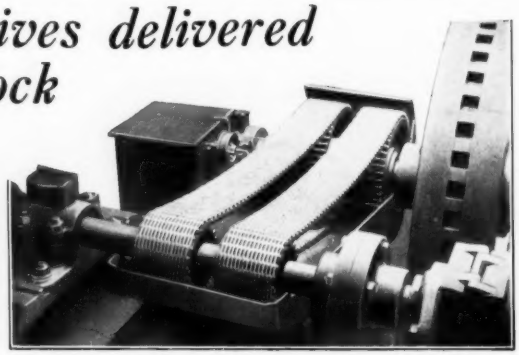

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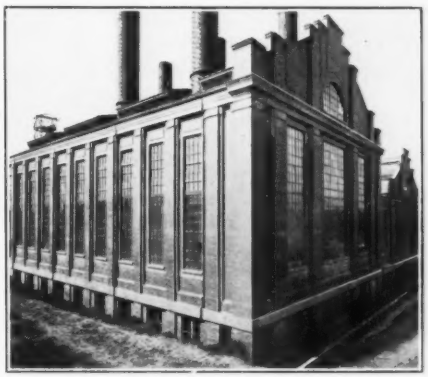

PRESTON.

BROADLY speaking the types of Stations erected in this country can be divided into four, as follows :— The "public building" type of station as built at Stourport for the Shropshire, Worcester and Staffordshire Electric Power Company. This station is constructed of artificial stone and brick on bold and imposing lines.

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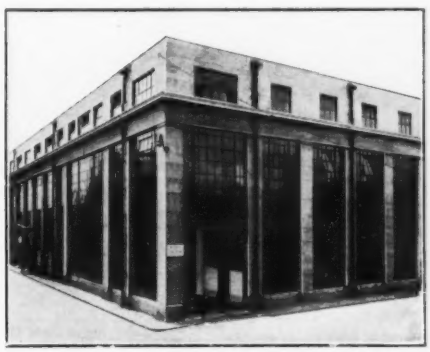

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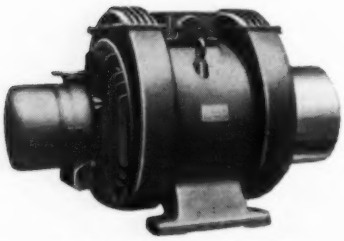

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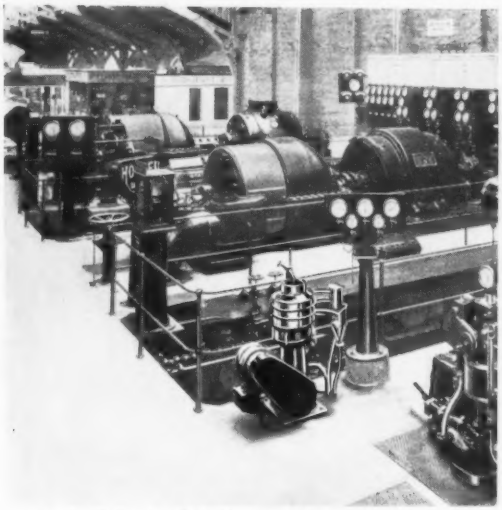

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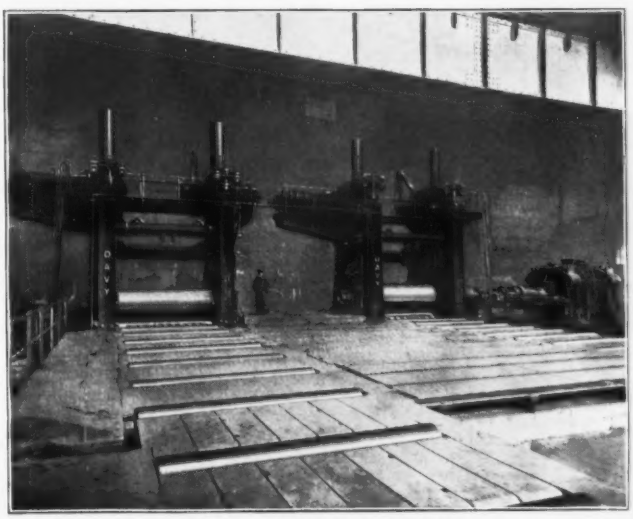

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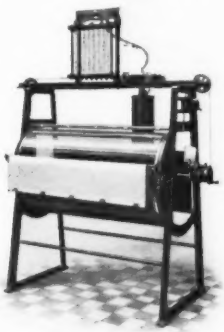

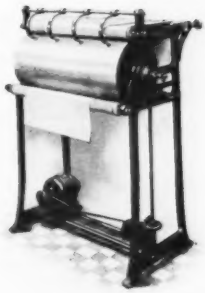

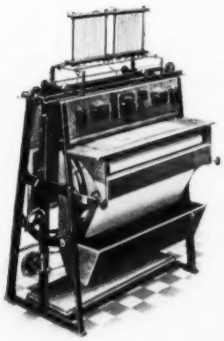

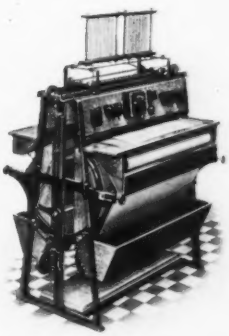

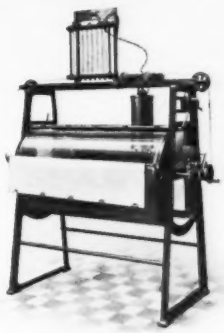

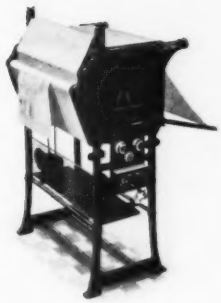

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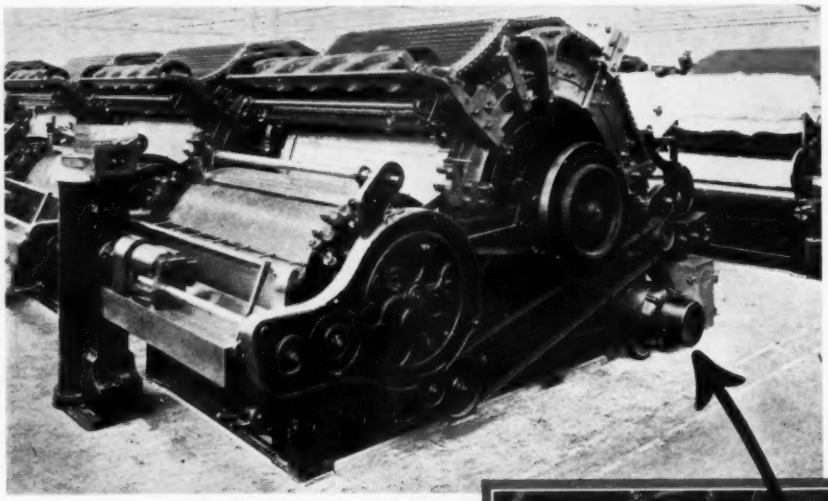

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